Super Mirrors at Lower Cost

NASA offers companies an innovative process for polishing precision aluminum optics.

Developed at Goddard Space Flight Center (GSFC), this technology uses diamond turning and polishing with a special compound to achieve a smooth surface—down to 5 angstroms—on an all-aluminum mirror. Mirrors fabricated using this process are lighter, less expensive, and more thermally stable than aluminum mirrors plated with electroless nickel.

Benefits

- **Low weight**—Mirrors made from aluminum are lightweight.
- **Thermally stable**—Bimetal thermal characteristics of nickel over aluminum are poor. Pure aluminum mirrors offer excellent thermal stability.
- **Low cost**—Plating aluminum surfaces with electroless nickel significantly adds to the cost of the optic.
- **Smooth surface**—GSFC's process yields a 5-angstrom flat and spherical mirrors and 10-angstrom aspherical mirrors, which are ideal for high-quality mirrors.
- **Consistent quality**—Plating electroless nickel onto aluminum can result in faults that preclude using the optic. GSFC's process consistently yields a high-quality surface and form.

Commercial Applications

Manufacturers of optics, metal optics, and diamond turning and polishing equipment could license and incorporate GSFC's process into their products. The high-quality optics achieved using GSFC's process can be used in a variety of applications:

- X-ray telescopes
- Cryogenic instruments
- Interferometry
- Medical imaging devices

National Aeronautics and Space Administration

The Technology

Researchers at NASA Goddard Space Flight Center have developed a revolutionary process for precision optical polishing of bare aluminum to an unprecedented smoothness. GSFC's process begins by using a single-point diamond turning machine. Grinding cannot be used on bare aluminum—it leaves behind particles that scratch the surface during polishing. Diamond turning alone, typically produces a 30- to 80-angstrom finish on standard aluminum materials. Therefore, additional polishing is required to achieve the needed smoothness for low-scatter, high-quality bare aluminum optics.

GSFC's process uses a special compound to polish the mirror to a super smooth finish. This compound not only offers superb lubricating qualities, but it also contains suspended particles. These particles are extremely hard and small, making the compound ideal for mirror polishing.

Flat and spherical mirrors polished with GSFC's process have a roughness of 5 angstroms rms while maintaining a surface figure accuracy of 0.125 of a wave peak to valley. Aspherical mirrors can be polished to a 10-angstrom rms finish.

The major benefit of this innovative process is the ability to make pure aluminum mirrors. Aluminum optics are less expensive and lighter than optics made from other pure materials. Also, nickel plating aluminum optics has drawbacks. Plating faults can ruin the optic, and the bimetal thermal characteristics of nickel over aluminum are poor, which is problematic for space and other applications with dramatic temperature swings. Finally, the nickel plating process can be expensive. By enabling the fabrication of high-quality aluminum mirrors, GSFC's process can dramatically reduce component fabrication cost, while improving the performance of the optical system.

Commercial Opportunities

This process is part of NASA's technology transfer program. The program seeks to stimulate commercial use of NASA-developed technology. GSFC has filed a patent application, and companies are invited to explore licensing the technology.

Contact

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